Los Alamos Environmental Restoration Records Processing Facility

ER Record I.D.# 71362

LOS ALAMOS NATIONAL LABORATORY
ENVIRONMENTAL RESTORATION
Records Processing Facility
ER Records Index Form

ER ID NO. 71362 ***Date Received:*** 1/22/2002 ***Processor:*** DSV ***Page Count:*** 21

Privileged: (Y/N) N ***Record Category:*** P

FileFolder: N/A

Correction: (Y/N) N ***Corrected No.*** 0 ***Corrected By Number:*** 0

Administrative Record: (Y/N) Y

Refilmed: (Y/N) N ***Old ER ID Number:*** 0 ***New ER ID Number:*** 0

Miscellaneous Comments:

VIEWGRAPHS: CONCEPTUAL MODEL OF MINERALOGICAL AND HYDROCHEMICAL IMPACTS OF THE CERRO GRANDE FIRE (ER2001-0920, LA-UR-01-6179)

THIS FORM IS SUBJECT TO CHANGE. CONTACT THE RPF FOR LATEST VERSION. (JUNE 1997)

14243

CONCEPTUAL MODEL OF MINERALOGICAL AND HYDROCHEMICAL IMPACTS OF THE CERRO GRANDE FIRE, LOS ALAMOS, NEW MEXICO

PATRICK LONGMIRE[1], DALE COUNCE[1], MICHAEL DALE[2], STEVE CHIPERA[1], AND MARJORIE SNOW[1]

1. LOS ALAMOS NATIONAL LABORATORY, EES-6, MS D469
2. NEW MEXICO ENVIRONMENT DEPARTMENT, DOE OVERSIGHT BUREAU

JAN 2 3 2002

41362

OBJECTIVE OF PRESENTATION

Present a conceptual model of dynamic changes occurring in mineralogy and hydrochemistry since the Cerro Grande fire, May 2000.

MOTIVATION OF INVESTIGATION

The Cerro Grande fire has enhanced dissolution of reactive minerals within soils and plants and produced new minerals forming in ash and muck. These minerals have reacted with rain and surface water. Subsequently, these reactions influence aqueous speciation, adsorption, and mineral equilibrium in surface water and alluvial groundwater.

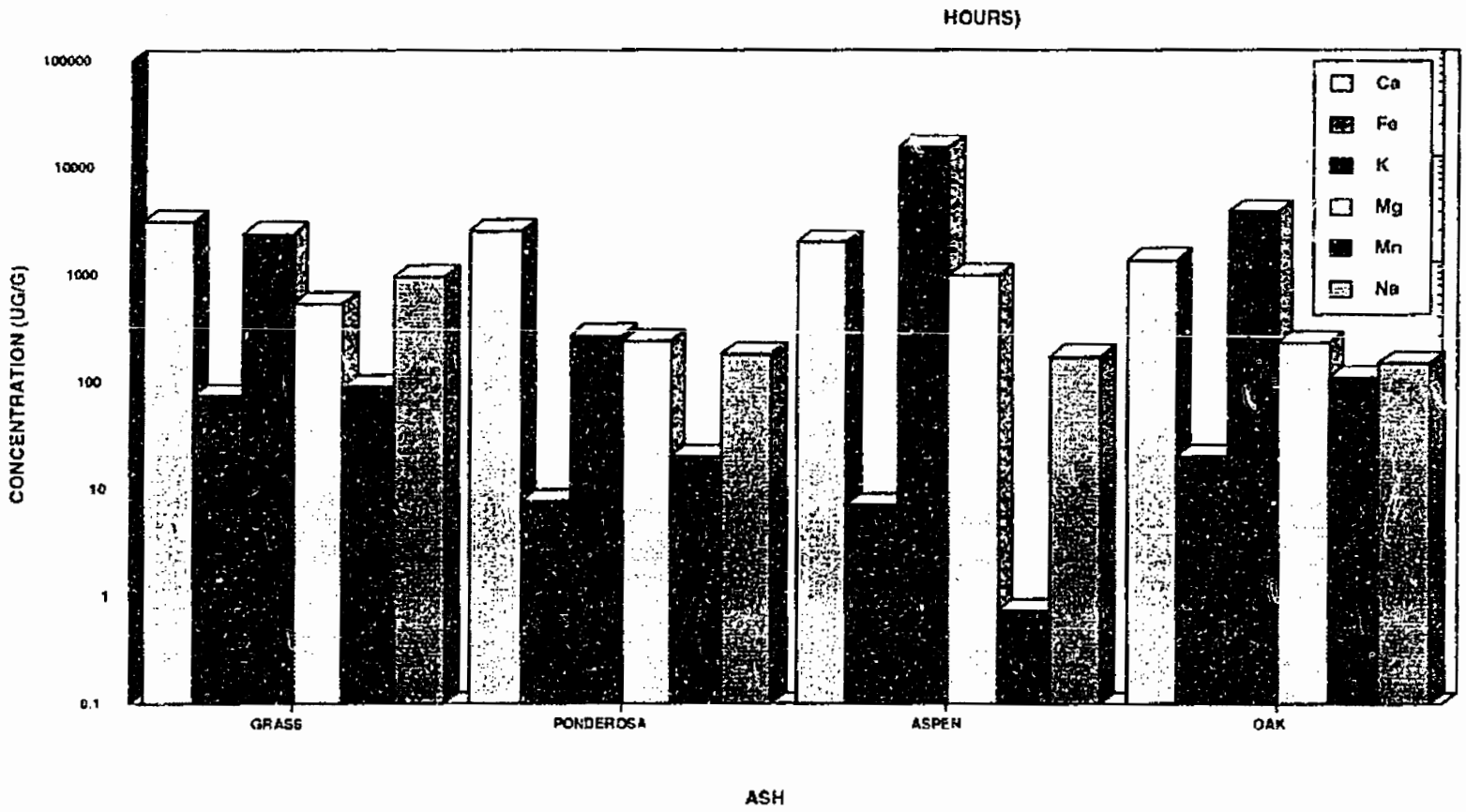
TOPICS OF INTEREST

- Chemistry and mineralogy of ash
- Aqueous chemistry of surface water
- Reactive mineral equilibrium
- Adsorption/desorption processes

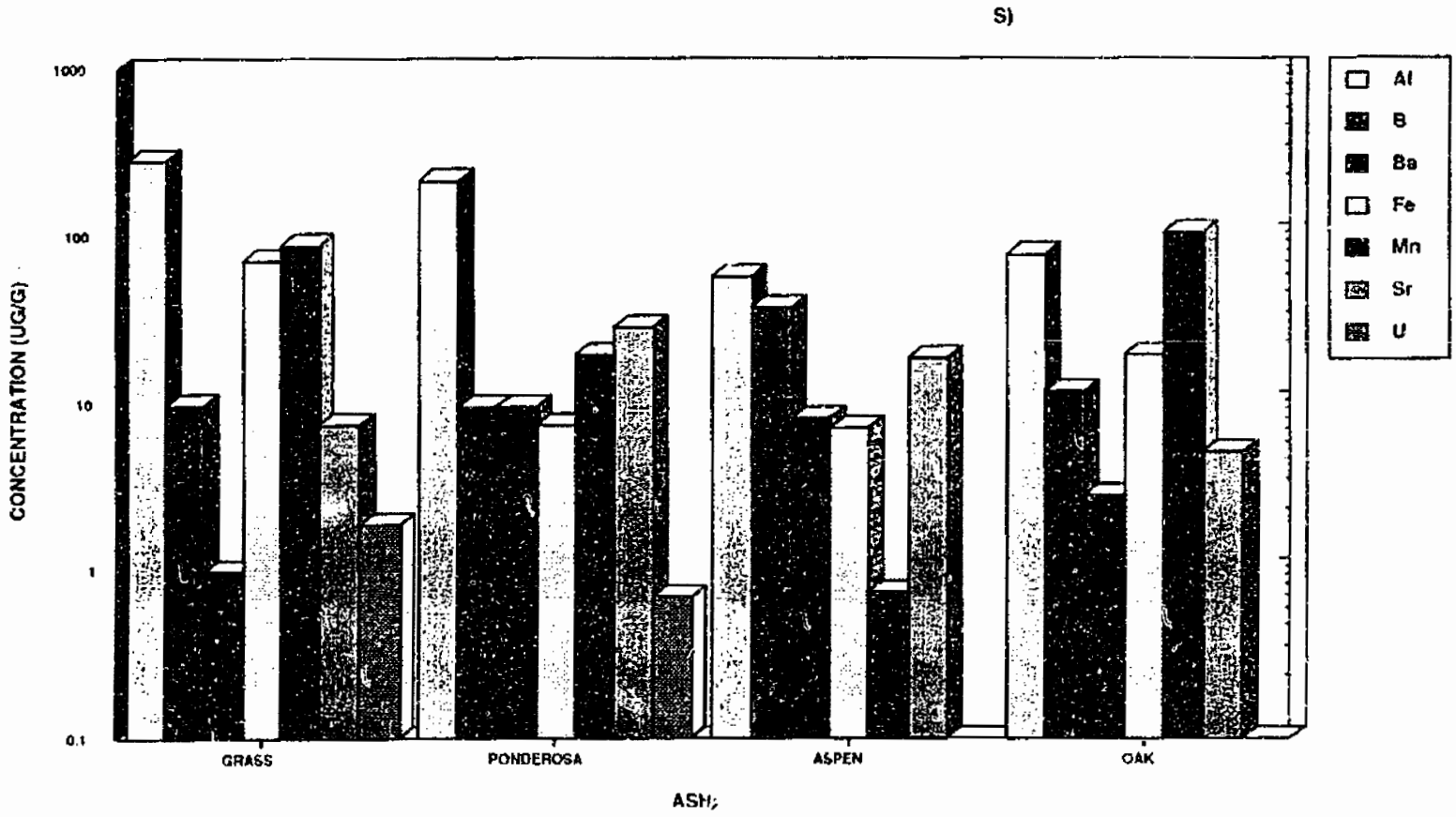
ANALYTICAL METHODS

- Metals- Inductively Coupled Argon Plasma Optical Emission
  - Spectroscopy (Al, Ba, Be, B, Ca, Fe, Mg, Mn, K, Na, Si, Sr, V, and Zn) Inductively Coupled Argon Plasma Mass
  - Spectrometry (Th and U)
  - Atomic absorption (Sb, As, Cd, Cr, Co, Cu, Pb, Hg, Mo, Ni, Se, Ag, and Tl)
- Anions- Ion Chromatography (Br, Cl, F, NO_3, NO_2, and SO_4)
- Alkalinity Titration
- X-Ray Diffraction
- Scanning Electron Microscopy

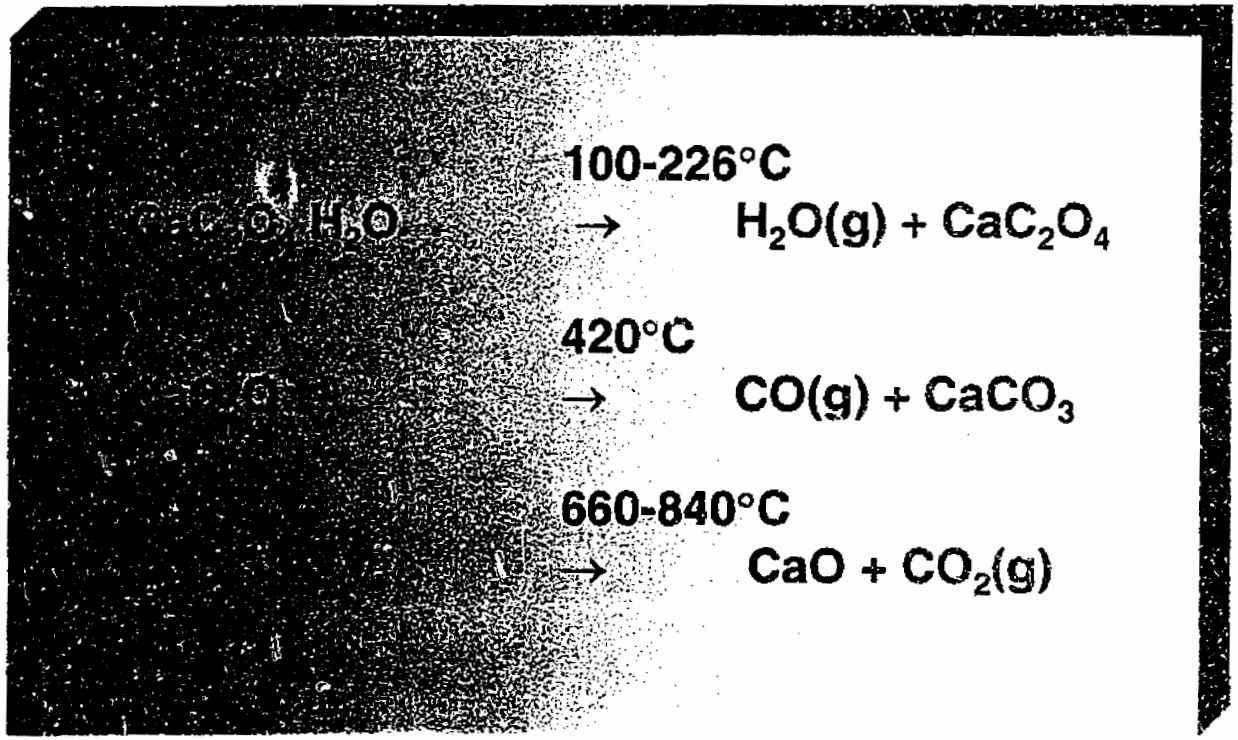
Results of Leach Tests on Cerro Grande Ash Using Deionized Water (Leach Time = 24 Hours)



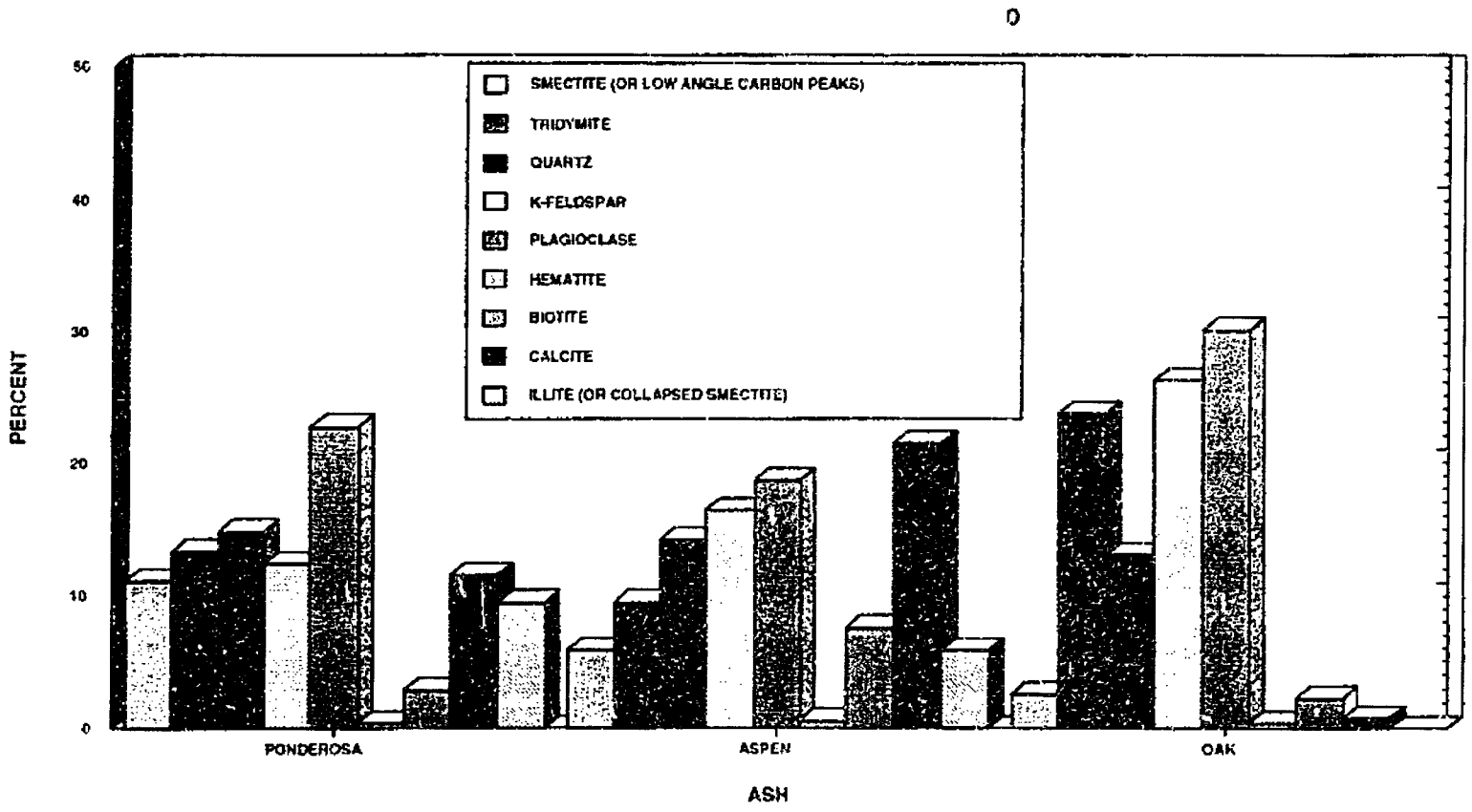
Results of Leach Tests on Cerro Grand Ash Using Deionized Water (Leach Time = 24 Hours)



DISSOLUTION OF $CaC_2O_4 \cdot H_2O$ AND PRECIPITATION OF $CaCO_3$ AND CaO (Pastor-Villegas et al., 1999)



Result of X-Ray Diffraction Analyses of Cerro Grand Ash, Los Alamos, New Mexico



OXIDATION REDUCTION CHEMISTRY OF CARBON, IRON, MANGANESE, AND SULFUR

Reaction	E°(V)	Eh (V) pH = 7.0	Assumptions
$MnO_{0.83} + 3.66H^+ + 1.66e^- = Mn^{2+} + 1.83H_2O$	1.305	0.561	Log $[Mn^{2+}] = -4.74$
$MnOOH + 3H^+ + e^- = Mn^{2+} + H_2O$	1.500	0.537	Log $[Mn^{2+}] = -4.74$
$Fe(OH)_3 + 3H^+ + e^- = Fe^{2+} + 3H_2O$	1.058	0.096	Log $[Fe^{2+}] = -4.75$
$SO_4^{2-} + 10H^+ + 8e^- = H_2S^0 + 4H_2O$	0.301	-0.217	Log $[SO_4^{2-}]$ = Log $[H_2S^0]$
$4H_2O + CH_3COO^- = 2HCO_3^- + 9H^+ + 8e^-$	0.187	-0.291	Log $[HCO_3^-] = -2.42$ Log $[CH_3COO^-] = -3.17$

OXIDATION REDUCTION CHEMISTRY OF IRON AND MANGANESE

$$MnO_{0.83} + 1.66Fe^{2+} + 3.15H_2O = Mn^{2+} + 1.66Fe(OH)_3 + 1.32H^+$$

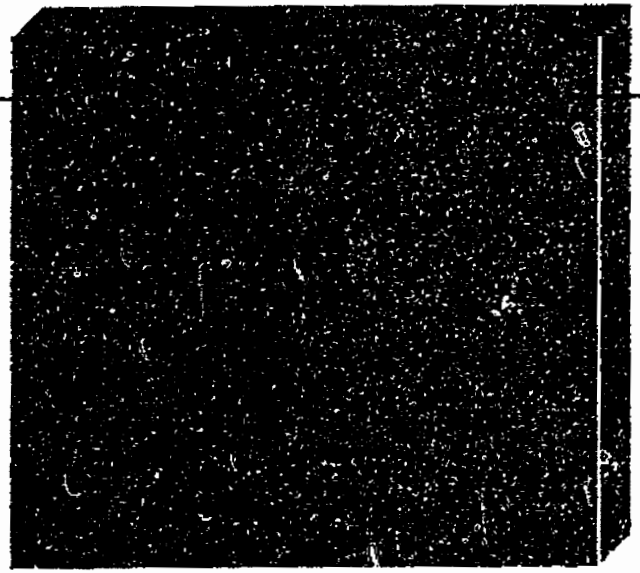
$$MnOOH + Fe^{2+} + H_2O = Fe(OH)_3 + Mn^{2+}$$

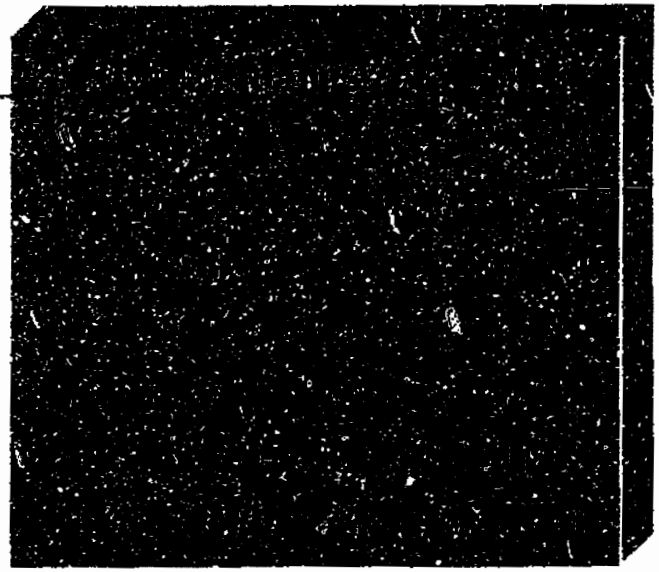
DISSOLVED IRON AND MANGANESE CONCENTRATIONS, PRE AND POST CERRO GRANDE FIRE, UPPER PUEBLO CANYON

Average (µg/L)

Range (µg/L)

Number of Samples





Source: D. Katzman. Water samples collected from upper Pueblo Canyon (surface water, PAO-1, PAO-2, PAO-4, and PAO-5N from June through October 2000).

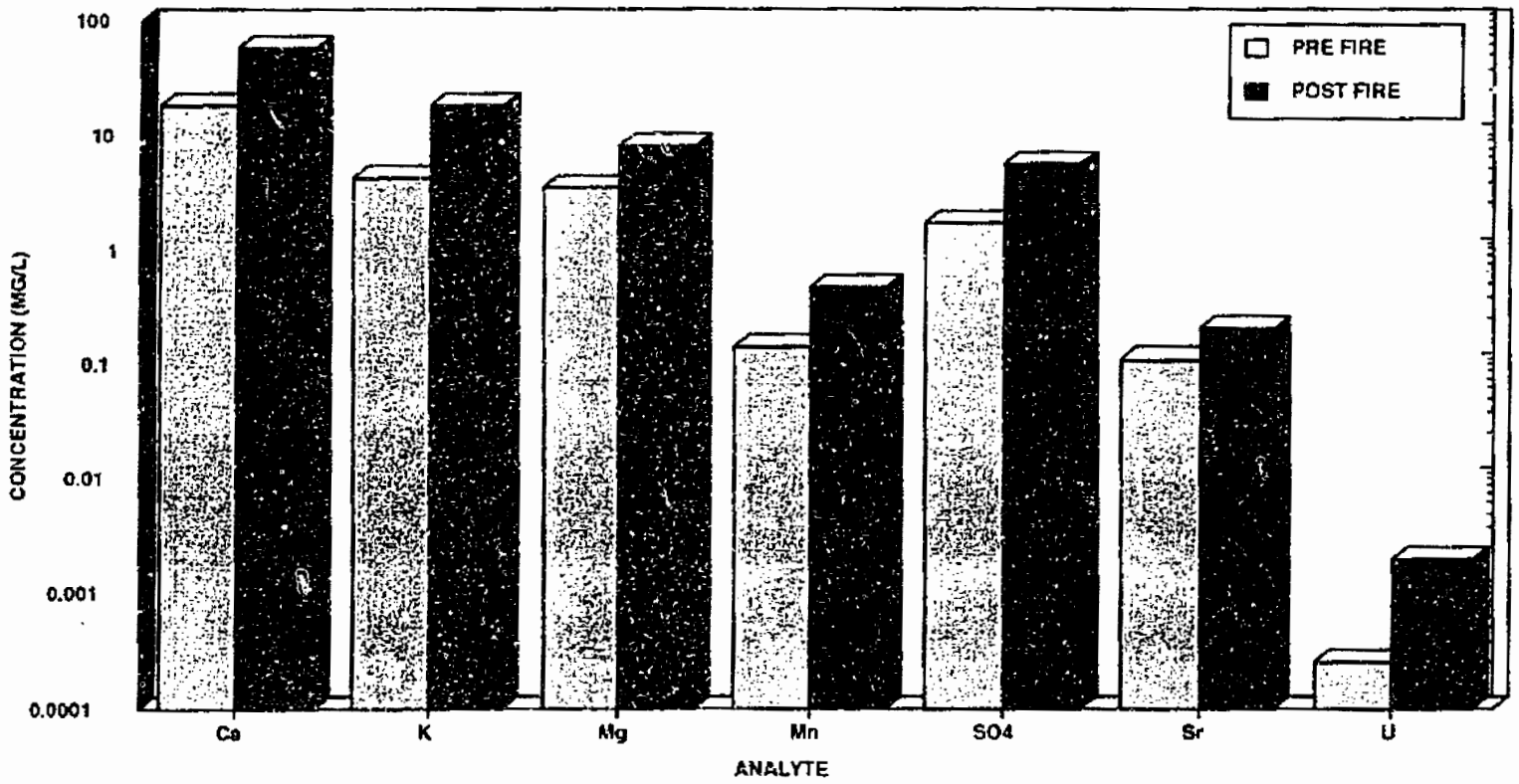
DISSOLVED BICARBONATE CONCENTRATIONS, PRE AND POST CERRO GRANDE FIRE

	Pre Cerro Grande Fire	Post Cerro Grande Fire
Average (mg/L)	48	105
Range (mg/L)	31 - 82	31 - 233
Number of Samples	26	24

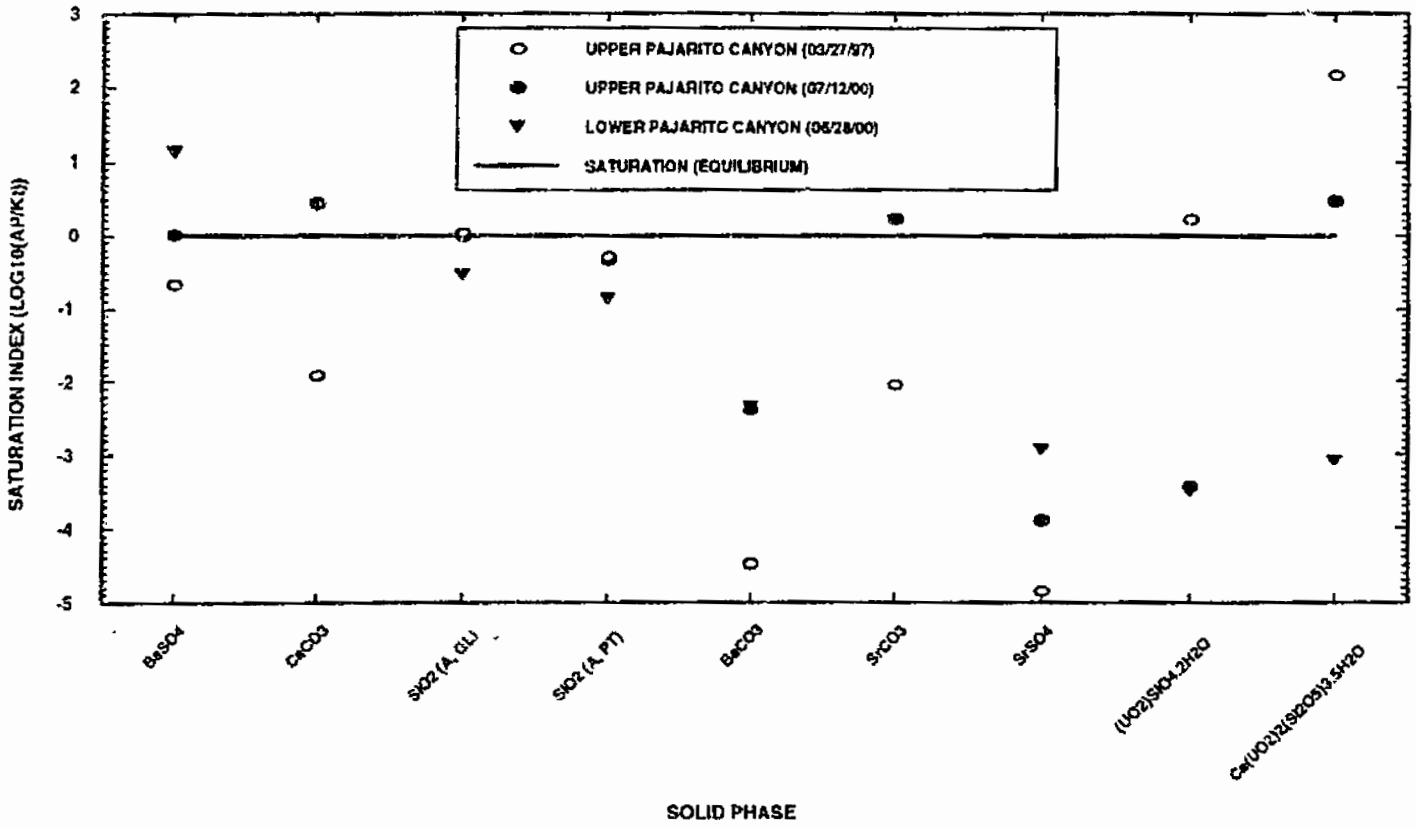
Source: M. Dale. Water samples collected from upper Pajarito Canyon (head waters), Starmer Spring, Homestead Spring, and Bulldog Spring from July 1994 through March 2001.

Average Concentrations of Selected Dissolved Analytes in Storm Water (Approximately 100 Samples) for Pre and Post Cerro Grande Fire (Bitner et al., 2001 and ESH-18, 2000)

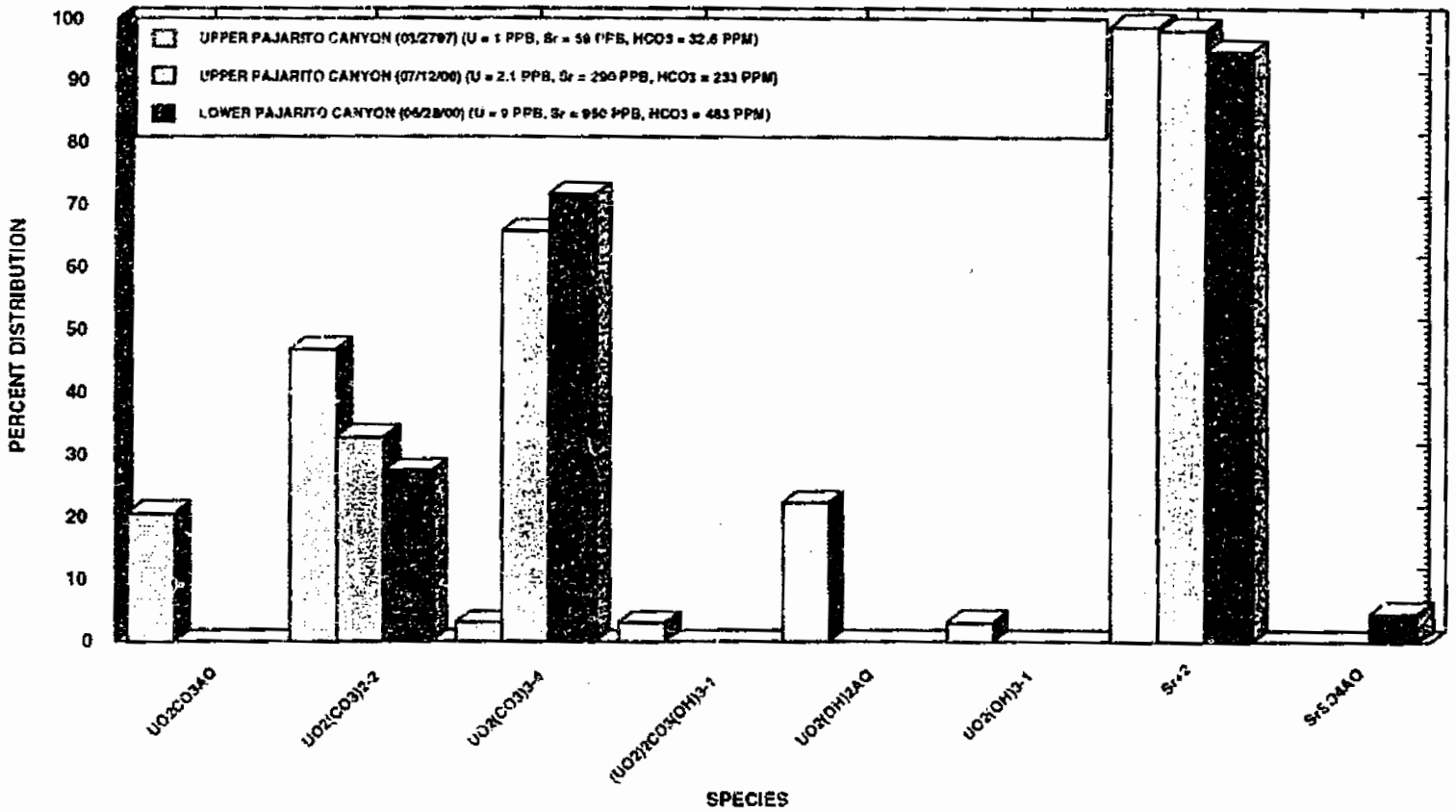
.TELY



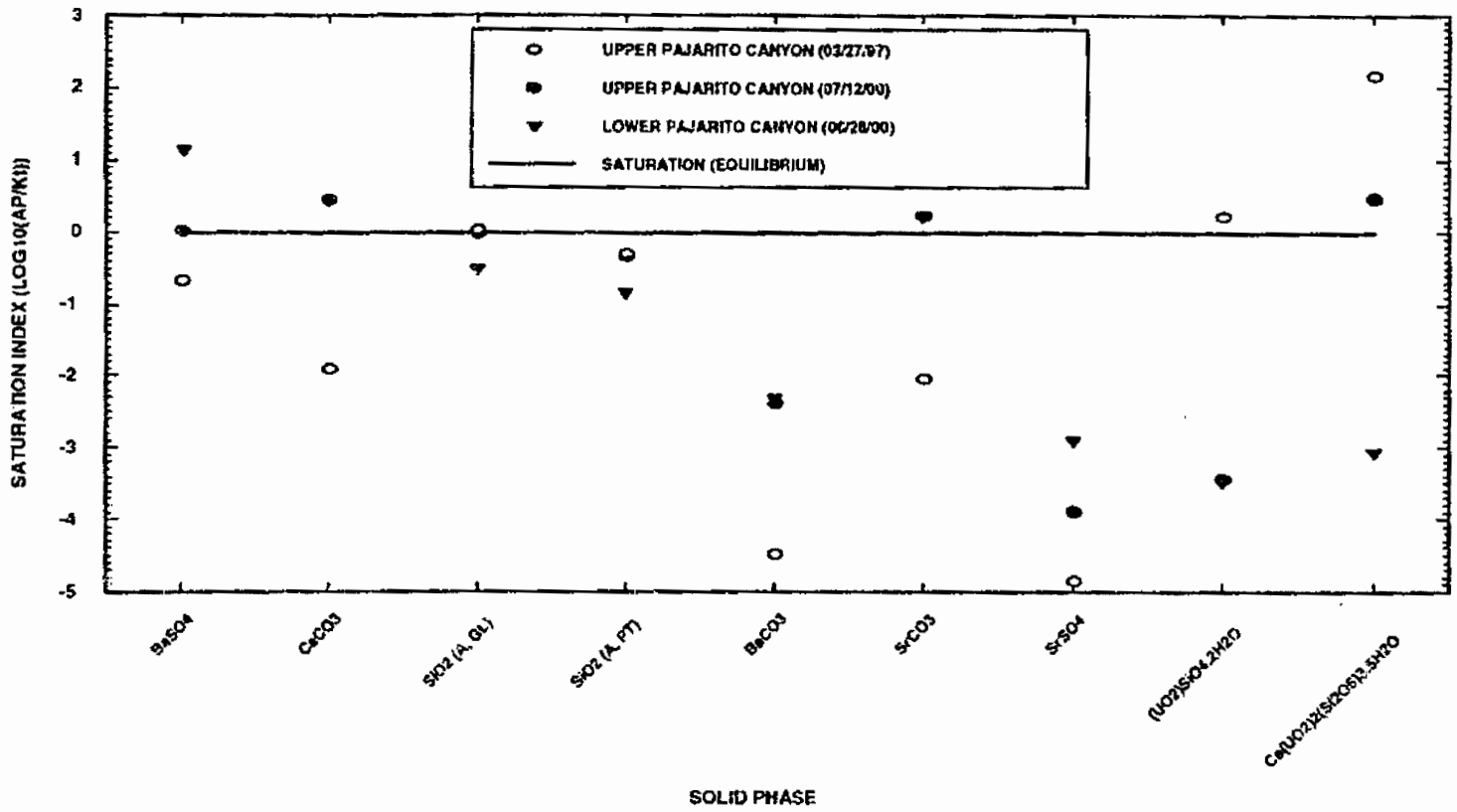
Results of Saturation Index Calculations Using MINTEQA2 For Pajarito Canyon, Los Alamos, New Mexico



Results of Speciation Calculations Using MINTEQA2 For Surface Water, Pajarito Canyon, Los Alamos, New Mexico



Results of Saturation Index Calculations Using MINTEQA2 For Pajarito Canyon, Los Alamos, New Mexico



SURFACE COMPLEXATION MODELING OF STORM WATER: DIFFUSE LAYER MODEL

The diffuse-layer adsorption model considers solution speciation and aqueous ion activities. The model uses the electric double-layer (EDL) theory. EDL theory assumes that the + or – surface charge of an adsorbent in contact with solution generates an electrostatic potential that declines rapidly away from the adsorbent surface. The potential is the same at the zero (adsorbent surface) and d (solution) planes.

The concentration of hydrous ferric oxide (HFO), based on total iron, is 0.73 g/L.

The specific surface area of HFO is 600 m^2/g.

SURFACE COMPLEXATION MODELING OF PAJARITO CANYON STORM WATER: DIFFUSE LAYER MODEL

Adsorbate	Dissolved		Adsorbed	
	mol/kg	percent	mol/kg	percent
Mn^{2+}	4.135E-04	100.0		0.0
UO_2^{2+}	5.189E-07	100.0		0.0
Sr^{2+}	1.135E-04	99.7	3.306E-07	0.3
Ba^{2+}	3.468E-06	99.1	3.005E-08	0.9
Ca^{2+}	3.366E-03	99.1	3.149E-05	0.9
SO_4^{2-}	7.490E-04	92.4	6.159E-05	7.6
Zn^{2+}	3.406E-06	3.2	1.036E-04	96.8
$H_3AsO_3^0$	4.955E-10	0.3	1.743E-07	99.7
$H_3AsO_4^0$	1.552E-12	0.0	1.833E-07	100.0
PO_4^{3-}	1.254E-09	0.0	2.739E-06	100.0

Water samples collected June 26, 2000 near State Road 4. pH of sample is 7.43.

SUMMARY OF MINERALOGICAL AND HYDROCHEMICAL CONCEPTUAL MODEL FOR CERRO GRANDE FIRE (ASH RICH)

$\geq 420C^{\circ}$, O_2, CO, CO_2

Cerro Grande Fire → Ash generation/dissolution/leaching
(> Ca, Mn, Mg, Na, K, Sr, U etc.)

→ Mineral transformation ($CaC_2O_4 \rightarrow CO(g) + CaCO_3$)

→ CO(g) and $CO_2(g)$ dissolution → $CO_2(aq) + H_2O = H_2CO_3^0 + HCO_3^-$

→ Complexation on metals with carbonate and bicarbonate ligands

→ Reduction and dissolution of manganese oxides-oxyhdroxides by ferrous iron and possibly dissolved organic carbon (reactive)

→ Precipitation of reactive minerals ($BaSO_4$, $CaCO_3$, and $SrCO_3$)

→ Competitive adsorption (hydrous ferric oxide) of $H_3AsO_3^0$, $H_3AsO_4^0$, Zn^{2+}, PO_4^{3-}, SO_4^{2-} with Sr^{2+} and UO_2^{2+}

→ Other adsorbents include solid organic matter, calcium carbonate, and clay minerals

Environmental Restoration Project
Document Signature Form

Document Catalog Number: ER2001-0920
(Please prefix the name of all electronic versions of this document with this number.)

Document Title /Subject: CONCEPTUAL MODEL OF MINERALOGICAL AND HYDROCHEMICAL IMPACTS OF THE CERRO GRANDE FIRE, LOS ALAMOS, NEW MEXICO

PRSs: None **Privileged Information:** Y / N

Associated Document Catalog Number(s): ER2001-0451

Author: Longmire, Patrick 665-1264 plongmire@lanl.gov

Author Organization: Canyons

Document Team: Coffin, Gracia PowerPoint presentation 665-5137 gracia@lanl.gov

Document Type: View Graph-External **Former OU:** N/A

Date Due: 11/9/2001 **Date Final Complete:** 11/9/2001

Date Sent to DOE: Unknown **Date Sent to NMED:** Unknown

Date Sent to RPF: 12/3/2001 **Received Per RPF:** Unknown

LA-UR Number: 01-6179 **RPF ER ID Number:** **Performance Measure:** No

AA Deliverable: No **Certification Required:** No **Force Peer Review:** No

Distribution TO: **Distribution FROM:**

Distribution COPY: **Distribution THRU:**

Attachment Notes:

Status/Comments: LA-UR-01-2798 Abstract

Reviewer Signatures: (By signing, the reviewer indicates that he/she reviewed and approves the document.)

Reviewer (Print reviewer's name under title)	Signature	Date
Proof Reader		
Author		
Team Leader		
ER Program Manager		
Distributed By		

Document Catalog Number ER2001-0920

Distribution THRU:	
Attachment Notes	
Status/Comments	

Reviewer Signatures: (By signing, the reviewer indicates that he/she **reviewed** and **approves** the document.)

Reviewer (Print reviewer's name under title)	Signature	Date
Proof Reader Tanya Herrera		11/6/01
Author Patrick Longmire	for Pat Longmire	11/6/01
Team Leader John McCann		11-6-01
ER Program Manager Julie Canepa		11/8/01
Distributed By Tanya Herrera	Tanya Herrera	11/9/01

Document Catalog Number ER2001-0920